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Taiwanese life scientists less "medialized" than their Western colleagues

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Abstract
The article presents results from surveys of life scientists in Taiwan (n = 270) and in Germany (n = 326). Fewer Taiwanese than German researchers have frequent contact with the media and they rate their experiences with journalists less positively. Furthermore, they are less prepared to adapt to journalistic expectations and to a greater extent than German researchers they expect journalists to consider scientific criteria in their reporting. These findings are interpreted in Weingart's "medialization of science" framework as indicators of lower medialization of science in Taiwan than in Germany. However, Taiwanese scientists are more willing than German scientists to accept journalistic simplification at the expense of accuracy. This is explained as an adaptation to the media system and to the perceived scientific literacy of the media audience. We hypothesize that cultural differences regarding the relative priority of relational vs. rational communication goals may also contribute to more tolerance of journalistic simplification in Taiwan.

Keywords
cross-cultural comparison, medialization of science, online survey, scientists and journalists

1. Introduction

Since the 1970s the relationship between science and the media has received a lot of attention in North America, Western Europe and Australia. The perception that this relationship is deficient has stimulated many communication studies as well as communication initiatives aiming to improve the relationship. Only with a time lag has this interest in public science communication spread to the recently modernized or modernizing countries in Asia, South America and Africa. For a long time, the focus of science communication researchers as well as that of science communicators was on the relationship of science and the (journalistic) mass media and on the interactions between scientists and journalists (e.g. Boltanski and Maldidier, 1970; Friedman et al., 1987; Willems, 1995).

Besides analyses of media science coverage, its reception by the audience and its effects on knowledge and attitudes, many studies have dealt with scientists' perceptions, attitudes and experiences regarding media coverage and journalism, and the interactions of scientists and journalists.

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In these studies, communication scholars have investigated scientific norms as barriers to researchers consenting to media interviews since in doing so they might risk their reputation (e.g. Boltanski and Maldidier, 1970; Dunwoody and Ryan, 1985) and the specific expectations of the scientific community about which scientists should represent science in what way in the public arena (Peters, 2013; Rödder, 2012). As possible causes of tensions between scientists and journalists, scholars have furthermore pointed to different professional cultures (Peters, 1995), different perceptions of what kind of information is relevant to the audience (Fahnestock, 1986), negative stereotypes and prejudices of scientists towards journalists (Krüger, 1987) and different quality criteria based on accuracy and new values, respectively (Salomone et al., 1990). Overall, the dominant perception of the science–media interface was that of a "gap" or "distance" between the realms of science and the media (Peters, 2013).

However, scientists, research organizations and scientific associations such as the American Association for the Advancement of Science (AAAS) have massively increased their efforts to gain media attention or, more generally, to be in the public eye. This development had already started in the early 1980s. Indicators are the expansion and professionalization of public information departments in universities and other research institutions, the foundation of mediating institutions such as science media centers (Fox, 2012), and science press release aggregators such as EurekAlert! or AlphaGalileo, as well as the organization of media training for scientists with the aim of improving their skills as information sources for the media (Trench and Miller, 2012).

"Selling Science" is what Nelkin (1987) called these strategies by scientific communicators to increase their public visibility and to control their public image. Based on the assumption that political support for science partly depends on its public visibility, many individual scientists and almost all publicly funded research organizations perceive the necessity of public communication. In order to be successful in their attempts to attract the attention of the media, scientific communicators have to know and, at least to some degree, have to adjust to journalistic expectations and routines, although these may in some respects be at odds with the communication norms and priorities that govern – or are normatively supposed to govern – the practice within science. Peters (2012) sees a trend towards institutionalization, professionalization and strategic utilization of media interactions by scientists as well as by scientific organizations.

Weingart (2001, 2012) diagnoses a strong development not only towards adaptation to the criteria of journalistic mass media in scientists' public self-presentation but also, as a consequence, towards assimilation and use of these criteria within science. He regards the main driving force behind this "medialization of science", as he terms this development, as the growing interdependency between science and other sections of society, and the increasing scrutiny of science by the mass media resulting from this closer "coupling" leading to a greater need for public legitimization. While many call for a reorientation in scientists' relationship with the media and welcome it, Weingart is more critical of this development as he fears that such a reorientation may not be confined to public communication but will have repercussions on internal scientific processes and will ultimately endanger scientific autonomy and thus the quality of scientific research.

In his discussion of the medialization concept, Weingart (2012) distinguishes three levels of medialization: the program, the organizational and the interactional level. Medialization at the program level would imply effects on the "core" of science. Which theories and methods are applied would then (partly) depend on journalistic criteria of how to gain public attention. At the organizational level, universities and other research institutes will use the expected media resonance as a criterion in their decisions. At the interactional level, scientific norms and quality criteria may change as a consequence of a higher priority of public communication within science and by diffusion of norms and routines from the public into the scientific arena. For example, Weingart and Pansegrau (1999) discuss the possibility that science would lose its monopoly in

assigning "reputation" as the status indicator valid within science and would replace it by public "prominence".

Communication scholars using the "medialization of science" paradigm to guide their research have found a great deal of empirical evidence in support of Weingart's thesis. Kohring et al. (2013) show that decision-makers in German universities consider media visibility of their organizations an important goal. Allgaier et al. (2013) conclude from semi-structured interviews with neuroscientists in Germany and the United States that researchers whose work is covered by the media have competitive advantages within their organizations as well as in obtaining access to external funding. Peters et al. (2008a) found evidence of a strong motivation on the part of scientists to interact with journalists as well as the perception of attendant career benefits. Franzen (2012) presents data suggesting that high-ranking scientific journals such as *Science* and *Nature* select manuscripts not only according to scientific quality but also on the consideration of their potential for attracting media attention. There is even some evidence that attempts to capture the attention of the media audience might affect research designs. For example, Peters (2012) reports a case in which a genetics researcher changed the "animal model" for his research from *Drosophila* to a butterfly species because he expected more spectacular images of modified insect wings and thus media interest in his research. On the basis of ethnographic observation of neuroscientific research groups, Heinemann (2012) argues similarly for the field of neuroscience and claims that some neuroimaging studies are mainly conducted because they promise coverage in the general media.

Overall, the evidence that scientists and scientific organizations perceive the benefits of publicity and anticipate that the media will increase their public legitimacy is quite strong (Kohring et al., 2013; Nelkin, 1987; Peters, 2012). However, researchers have challenged the assumption of a universal medialization process and looked for counter-effects pointing, for example, to the prevailing ambivalence of traditional scientific norms with respect to public communication (Rödder, 2012) and to variations in medialization according to research field (Schäfer, 2007). There is also the open question concerning cross-national differences in the kinds and degrees of medialization. Motivations and opportunities to seek media visibility may vary depending on, for example, the size and international competitiveness of the national science system, scientific literacy of the population and public interest in science, existence of professional science journalism, and the political system, in particular the role of the public in science governance and the medialization of politics. While the available evidence from cross-national studies indicates general similarity in science orientation towards the media between major knowledge-producing countries (Allgaier et al., 2013; Peters et al., 2008a), less is known about developing or recently developed countries (e.g. Kreimer et al., 2011), and very few studies include comparisons between the major science nations established in the past decades and advancing countries (e.g. Bentley and Kyvik, 2011). On the basis of cross-cultural surveys of biomedical researchers (Allgaier et al., 2013; Peters et al., 2008a), we consider Germany as a typical example of major Western knowledge-producing countries with respect to the science–media interface.

Our study aims at contributing some empirical evidence on similarities and differences regarding scientists' orientation towards the media in Germany, as an example of a major Western science nation, and Taiwan, as a modernizing Asian country. It may appear questionable whether the medialization of science theory developed for Western knowledge societies can be applied to "emerging" knowledge countries such as Taiwan. However, the theory claims a *process* of medialization and Taiwan and Germany may be thought to represent different phases of that process. Furthermore, while the societies differ in many respects, Taiwan is clearly using the Western type of science system as a model for the development of its own science system. We therefore consider it legitimate to use the medialization theory as a theoretical framework to compare the media orientation

of scientists in Taiwan and Germany while keeping in mind that the social contexts of science may be quite different in the two countries.

The research reported in this article deals with medialization at the interactional level. In particular, it compares German and Taiwanese scientists' understanding of their own role regarding interactions with journalists and their expectations of journalism. In the medialization concept the turn of science towards the media and its anticipation of media criteria in public communication is the first and most immediate response to address the assumed demand for public legitimacy. So it seems adequate for our initial comparative study to use indicators describing scientists' adaptation to the media. The science–media relationship in Germany has been extensively studied (e.g. Kohring, 1997; Krüger, 1987; Peters, 1995; Weingart, 2001), but empirical evidence about Taiwan is more limited as Huang and Jian (2010) argue. In Taiwan, the importance of science communication has only recently been acknowledged. In 2007, the "Grand Project for the Development of the Taiwan Science Communication Industry" was established with the goal of improving communication about science with the public.

Several authors have looked at science–media relations in Taiwan. An early study by Hsieh (1984) found infrequent contacts between Taiwanese scientists and journalists, and that scientists had a negative stereotype of journalists. In a later publication, she claimed that Taiwanese researchers were living in a world of their own and were reluctant to interact with journalists (Hsieh, 2006). Also Han (1990), a practicing journalist, criticized the absence of Taiwanese scientists in the media. One of the reasons she mentioned was the poor relations between scientists and journalists in Taiwan. Taiwanese scientists and journalists have frequently expressed their dissatisfaction with the media coverage of science (Chen, 2011; Feng, 1995; Han, 1990). Fu (1996), who interviewed 40 Taiwanese life scientists working in the "Academia Sinica", found that researchers disseminated science information to non-scientists only infrequently. Nevertheless, her interviewees showed positive attitudes towards popularization activities based on expected benefits for the education of the population, for policy and for securing research funding. More recently, Chen (2011) studied discrepancies between scientists and journalists with respect to expectations of media coverage and science–journalist interactions in Taiwan. The study, based on a survey of 1,046 scientists and 67 journalists, showed some discrepancies between the two groups. While journalists and scientists mostly agreed on media functions such as public education and information dissemination, Chen observed different assessments of media coverage and journalism. For example, to a greater extent than journalists, scientists perceived media stories to be dramatized, over-simplified, poorly translated and misleading.

The present study does not compare scientists' and journalists' expectations of each other and of media coverage as Chen (2011) and Peters (1995) have done in Taiwan and Germany, respectively, but rather compares Taiwanese and German scientists' expectations of the media and their conception of their own role. Our research questions are: Do Taiwanese and German researchers differ in their anticipation of the expectations journalists have of them? And do they differ in their acceptance of typical journalistic ways of covering science and dealing with scientific sources? The journalistic expectations serving as a reference to determine the degree of "medialization" of scientists are not empirically determined in this study but rather assumed on the basis of, e.g., Chen (2011) and Peters (1995).

2. Methods

Data about life scientists' involvement in public communication, in particular about their interactions with the journalistic mass media, were gathered in 2011 by online surveys of life scientists in Taiwan and Germany. The questionnaire was developed as part of a larger German collaborative

project aiming at analyzing the interdependencies between science and the media, and using the medialization paradigm of Weingart as a conceptual framework (Peters et al., 2012). Among other topics, the questionnaire included questions about the respondents' beliefs about and attitudes towards the media, perception of their own role in the public communication of science, perceived expectations of their social context, experiences with the media, and repercussions of anticipated media publicity on their research. For the Taiwanese survey, a shortened English version of the questionnaire was used. This article focuses on a comparison of the Taiwanese and German results.

The sample of the original German survey was composed of 16 independently constructed disciplinary subsamples covering scientific disciplines from the humanities, social sciences, life sciences, natural sciences and engineering. In order to reduce the complexity of the comparison between countries and allow the construction of equivalent samples for both countries, we confined the Taiwanese survey to two subsamples – biology and neuroscience – that we consider typical of research fields in the life sciences. In both fields most researchers publish in international English-language journals that are covered by Web of Science. The samples of scientists from these two disciplines were similarly constructed for both countries. We created lists of authors from journals relevant to the respective fields for both countries and drew random samples for each field and country from the authors who had published in relevant journals of the respective field at least twice within the past two years.

As the analysis led to quite similar results for both research fields in each country (see online appendix), we combined the two subsamples for the country comparison and we report results for the combined country samples in the following. To compensate for the different composition of the country samples by research field (i.e. number of biologists vs. number of neuroscientists), we used weights. These weights were calculated to emulate country samples composed of 50% biologists and 50% neuroscientists, correcting the imbalance resulting from the fact that in the original samples 53% (Taiwan) and 74% (Germany), respectively, of the responses are from neuroscientists. All the statistical results reported in this article are based on weighted data. The weighting ensures that the country differences identified in the analyses are not affected by the different disciplinary composition of the original samples.

By design, the samples of biologists and neuroscientists are representative for the population of publishing researchers in the two fields according to the operational definition of the statistical population presented above. They are not representative for all scientists, not even for all life scientists in the two countries. The validity of our country comparison depends on the *equivalence* of the country samples, not on their representativeness for the total population of researchers in both countries. We used two different disciplinary subsamples in order to make sure that the results are not only typical for one specific research field. Based on the similarity of results of the two research fields, we consider it likely that the general findings regarding country differences can be generalized to the life sciences.

Surveys in both countries were implemented using *SoSci Survey*, a German software/server system for online surveys widely used in academic survey research.[1] In designing and mailing the invitations and reminders, we were guided by the principles of the Total Design Method (Dillman et al., 2009). The initial invitation to participate in the survey by email was followed by up to five email reminders in the following weeks, sent to those who had not responded so far. Invitations were emailed to 1,544 Taiwanese and 1,322 German scientists. Excluding email addresses from the calculation which were not successfully reached (error message from receiving email server), the effective response rates were 20.8% (Taiwan) and 32.2% (Germany).[2]

In total, we received 596 valid responses – 270 from Taiwanese and 326 from German life scientists. In both countries, our samples of life scientists mostly consist of male researchers in

Table 1. Sample composition.

		Original sample		Weighted sample	
		Taiwan	Germany	Taiwan	Germany
Research field	Biology	46.7%	26.1%	50.0%	50.0%
	Neuroscience	53.3%	73.9%	50.0%	50.0%
	Total	100.0%	100.0%	100.0%	100.0%
		(n=270)	*(n=326)*	*(n=270)*	*(n=326)*
Age (recoded)	< 36 years	4.9%	15.4%	5.0%	13.1%
	36–45 years	32.1%	37.9%	31.9%	38.5%
	46–55 years	43.0%	29.8%	43.1%	31.1%
	56–65 years	17.4%	11.3%	17.2%	11.5%
	> 65 years	2.6%	5.6%	2.7%	5.8%
	Total	100.0%	100.0%	100.0%	100.0%
		(n=265)	*(n=319)*	*(n=265)*	*(n=319)*
Gender	Female	17.9%	25.7%	17.7%	28.8%
	Male	82.1%	74.3%	82.3%	71.2%
	Total	100.0%	100.0%	100.0%	100.0%
		(n=262)	*(n=323)*	*(n=262)*	*(n=324)*
Management role ("Which term best describes your current management role in your unit?")	Dean, head of institute, director, head of department, CEO, chair	27.4%	23.7%	27.4%	23.7%
	Group leader, principal investigator	54.1%	55.4%	54.0%	57.8%
	Other management position	5.6%	12.8%	5.6%	11.7%
	No management position at this time	13.0%	8.0%	13.0%	6.9%
	Total	100.0%	100.0%	100.0%	100.0%
		(n=270)	*(n=312)*	*(n=270)*	*(n=317)*

advanced stages of their careers (Table 1). About 80% of the respondents have a leadership function as principal investigator, group leader, or institute director, for example.

3. Results

Frequency and assessment of media contacts

For major knowledge societies, it has been shown that the gap between science and the media in terms of interaction frequency and satisfaction of researchers with these interactions is less wide than was long assumed. In a survey of biomedical researchers in the United States, Japan, Germany, the United Kingdom and France in 2005–06, about 70% of the researchers reported at least one media contact in the past three years and 30% as many as 6 or more contacts – with little variation between the five countries included in the study (Peters et al., 2008a). In the present survey of life scientists, using a similar sampling strategy and the same question design, this figure was roughly replicated for Germany. Seventy-four percent of the German respondents said that they had had at least one contact in the past three years, 25% mentioned 6 or more contacts. Compared with these figures, the frequency of contacts with the media is somewhat lower in Taiwan, but not dramatically different (Table 2). Sixty percent of the Taiwanese respondents reported at least one contact

Table 2. Frequency, characteristics and evaluation of media contacts.

		Taiwan	Germany
Frequency of media contact ("In the past 3 years, have you had professional contact with journalists from the general mass media face-to-face, by phone or in writing (email, regular mail, fax)?")	No contact	40.0%	25.7%
	Yes, 1–5 times	43.4%	49.3%
	Yes, 6–10 times	8.3%	11.3%
	Yes, more than 10 times	8.2%	13.7%
	Total	100.0%	100.0%
		(n=270)	*(n=326)*
Evaluation of media contacts[a] ("Altogether, how would you describe your contact with journalists in the past 3 years?")	Mostly good	56.6%	75.1%
	Mostly bad	6.3%	2.5%
	Good and bad experiences are relatively balanced	23.1%	15.8%
	Neutral	14.1%	6.7%
	Total	100.0%	100.0%
		(n=158)	*(n=242)*
Type of journalist[a] ("The following questions refer to your most recent contact with journalists […] What kind of journalist(s) did you have contact with?")	Journalist was specialized in covering science	36.2%	61.4%
	Journalist was not specialized in covering science	57.3%	32.9%
	Don't know	6.5%	5.8%
	Total	100.0%	100.0%
		(n=146)	*(n=219)*
Main topic of talk with journalist[a] ("What was the main topic of the most recent conversation, interview or exchange of information? If there was more than one topic, mark the topic that received the most attention.")	Actual research and findings of this research (including potential practical applications)	28.5%	41.8%
	State of research on a certain topic (including potential practical applications)	23.2%	18.6%
	General expertise on a certain topic, event or problem	46.9%	33.9%
	Other topic	1.4%	5.7%
	Total	100.0%	100.0%
		(n=144)	*(n=221)*

Note: Results are based on weighted data (see text).
[a]Only respondents who had talked to a journalist in the past 3 years.

with the media in the past 3 years; for 17% such contacts were relatively frequent (6 or more contacts in three years). As in the previous study mentioned above, most life scientists in both countries rated their overall experiences during their own media interactions rather positively; only a few rated them rather negatively. However, Taiwanese life scientists were somewhat less positive than German scientists (Table 2). In part, the difference in evaluation of media contacts between Taiwanese and German life scientists could be the consequence of different styles of journalism in the two countries with which scientists are faced, i.e. a different degree of professionalism in covering science or a different affirmative/critical tone towards science. Our survey results indeed show that in Taiwan professional science journalism plays a less prominent role than in Germany. Asked about the type of journalist in their most recent encounter with the media and about the main

Table 3. Scientists' normative beliefs regarding their interactions with journalists.

Item[a]	With media contacts, scientists should . . .	Taiwan (mean[b])	Germany (mean[b])	Difference of means[c]
I1	use catchy phrases that can be quoted verbatim by reporters	0.07	0.80	–0.72**
I2	play along if journalists are not only interested in scientific results, but are also interested in them personally	–0.45	–0.16	–0.29**
I3	communicate their results and expertise in an entertaining manner	–0.31	1.10	–1.41**
I4	relate their research to the everyday experience of the media public	0.63	1.36	–0.72**
I5	use their expertise to criticize political, economic, and other decisions affecting society or make practical suggestions for action	0.16	1.02	–0.86**
I6	if asked, provide information about current research or research that has not yet appeared in scientific publications	–0.41	–0.34	–0.07
I7	if asked, speak openly about problems, such as misconduct on the part of researchers or controversial research practices	0.45	0.94	–0.49**
I8	share internal scientific differences of opinion with the general public[d]	0.31	0.15	0.16
I9	schedule a lot of time	–0.32	0.07	–0.39**

Note: Results are based on weighted data (see text).
[a]Items were presented in randomized order.
[b]Mean ratings on a 5-step scale ranging from -2 (completely disagree) to +2 (completely agree).
[c]Statistical significance of difference of means (t-test): * $p < 0.05$, ** $p < 0.01$.
[d]In the questionnaire, the item read "… *not* share internal scientific differences of opinion with the general public." To make this item consistent with the "direction" of the other items – higher values indicating stronger agreement to assumed expectations of journalists – the values have been recoded. All values were multiplied by -1, thus reversing the scale.

topic of the talk, Taiwanese researchers answered less frequently that they had interacted with a science journalist and that the main topic of their talk was "research" (Table 2).

Scientists' perception of their role regarding interactions with the media

Another possible explanation for the different evaluations of media interactions by life scientists in Taiwan and Germany might be a difference in the criteria of satisfaction between researchers in those countries. Scientists aiming at increasing their visibility in the media in order to gain public legitimacy or support, as suggested by the medialization thesis of Weingart, might tend to accept the way media report on science more readily, or even anticipate those media criteria in their own interactions with journalists. If that is the case, a stronger medialization of science in Western countries and thus a stronger media orientation of German scientists should be reflected in their perceived role as public communicators.

A question asking life scientists in both countries about "their expectations of how scientists should act with media contacts" included nine items stating (assumed) expectations of journalists towards scientists as their interview partners (Table 3). These items refer to media criteria such as a preference for entertaining and personalized stories with relevance for the media audience, and openness towards journalistic inquiry in terms of spending time with the media and answering

questions about science in the making and about critical issues that may raise public doubt about the performance of science. Respondents could indicate their agreement or disagreement with these items on 5-step rating scales. Higher values indicate stronger compliance with journalistic expectations.

With the exception of two items (I6 and I8), for which expected differences are found only in one of the two subsamples (see online appendix, Table A3), Taiwanese and German life scientists differ significantly in their acceptance of journalistic expectations. Taiwanese researchers are consistently less prepared to adapt to journalistic expectations (Table 3). For example, they are much less inclined to conform to the style of journalistic writing and "use catchy phrases that can be quoted verbatim by reporters" (I1) or to "communicate their results and expertise in an entertaining manner" (I3). They are also more reserved regarding a contextualization of research in everyday life or societal decision-making than German researchers and thus agree to a lesser extent with demands that scientists should "relate their research to the everyday experience of the media public" (I4) and "use their expertise to criticize political, economic, and other decisions affecting society or make practical suggestions for action" (I5). Playing along when journalists want to focus on the researcher as a person (I2), as may be demanded by journalists who like to "personalize" their stories, is rejected by respondents in both countries, but more strongly by Taiwanese researchers.

Providing "information about current research or research that has not yet appeared in scientific publications" (I6) is rejected by scientists from both countries. This response probably results from the existence of a scientific norm that gives priority to internal scientific communication over public communication. According to our hypothesis of less medialization in Taiwan, we would expect stronger rejection of that demand by Taiwanese researchers. This expectation is confirmed only in the neuroscience subsample, while the answers of biologists do not significantly differ (see online appendix, Table A3). The norm of priority of scientific communication is reflected and reinforced by the so-called "Ingelfinger rule", according to which editors of important scientific journals reject manuscripts based on results that have already been covered by the general mass media (Kiernan, 1997). Asked about the existence of the Ingelfinger rule in a separate question, a majority of researchers from both Taiwan (52%) and Germany (61%) at least partly agreed that the "acceptance of a publication by a scientific journal [is] threatened if the research results have already been reported in the mass media". Overall, Taiwanese and German scientists are similarly ambivalent about sharing "internal scientific differences of opinion with the general public" (I8). The responses suggest that Taiwanese as well as German life scientists see internal scientific communication as an exclusive arena that is somewhat separated from public communication. Only in the biologist subsample do we find the expected country difference (see online appendix, Table A3). Scientists in both countries agree with the statement that "if asked, [they] should speak openly about problems, such as misconduct on the part of researchers or controversial research practices" (I7) but German researchers agree more strongly.

The readiness of scientists to "schedule a lot of time" for media contacts (I9) indicates the relative significance of those contacts compared to other tasks of scientists such as research, teaching students or administrative work, for example. Using that indicator, the priority of interactions with the journalistic media seems to be higher for scientists in Germany than for those in Taiwan. However, even in Germany the enthusiasm for spending much time with journalists is rather limited. Accordingly, a survey of German and US neuroscientists using semi-structured interviews showed that although most researchers rated public communication and the mass media as important and part of their role, many considered this activity a "duty" distracting them from their primary tasks and thus only a peripheral part of their role as scientists (Allgaier et al., 2013).

Table 4. Scientists' demands from journalists.

Item[a]	Journalists should . . .	Taiwan (mean[b])	Germany (mean[b])	Difference of means[c]
I1	consult the scientists they have interviewed prior to publication in order to avoid making factual errors	1.51	1.89	-0.38**
I2	compromise scientific accuracy in what they report	0.22	–0.68	0.89**
I3	select their interviewees from science based strictly on the criterion of professional reputation	1.10	0.58	0.52**
I4	only report on research results that have already appeared in scientific publications	1.00	0.49	0.51**
I5	only ask scientists about topics on which they have done research themselves	0.77	0.68	0.09
I6	support scientists in educating the general public	1.63	1.57	0.07
I7	acknowledge that scientific expertise is more credible than the knowledge of practitioners based on professional experience	0.83	0.26	0.56**
I8	report about research methods and processes so that the general public can understand the reasons for scientific claims	1.16	1.51	–0.35**

Note: Results are based on weighted data (see text).
[a]Items were presented in randomized order.
[b]Mean ratings on a 5-step scale ranging from -2 (completely disagree) to +2 (completely agree).
[c]Statistical significance of difference of means (t-test): * $p < 0.05$, ** $p < 0.01$.

Expectations of journalism

Different degrees of medialization of science could furthermore be reflected in the greater or lesser acceptance of common journalistic approaches that are at odds with the scientific culture. A question, using the same 5-step rating scales of agreement/disagreement as before, presented eight items concerning what scientists might normatively expect from journalism in spite of possibly different journalistic practices and preferences (Table 4). Again, with the exception of two items, the mean values differ significantly between the Taiwanese and German subsamples.

It is obvious from their responses to four items that life scientists in both countries expect journalists to consider scientific rather than genuine journalistic criteria in their reporting on science, but Taiwanese scientists expect this more clearly than German scientists. Taiwanese scientists more strongly agree that "journalists should select their interviewees from science based strictly on the criterion of professional reputation" (I3), that they "should only report on research results that have already appeared in scientific publications" (I4) and that they "should acknowledge that scientific expertise is more credible than the knowledge of practitioners based on professional experience" (I7). In another item stating that "journalists should only ask scientists about topics on which they have done research themselves" (I5), the difference between Taiwanese and German respondents is congruent with the results of the three items presented before, but statistically not significant. Taken together, the comparison of the responses to the four abovementioned items suggests that German scientists are more prepared than Taiwanese researchers to accept that journalists use their own professional criteria in science reporting rather than applying those used within science.

Other items concerning the expected scientific accuracy and epistemic detail of the media coverage do seem to fit into the pattern of German researchers' being prepared to make more

compromises regarding scientific criteria, however. The largest discrepancy between respondents from the two countries is in the agreement with the item that "journalists should compromise scientific accuracy in what they report" (I2). While Taiwanese scientists tend to be ambivalent or even slightly in favor of this statement, German scientists on average moderately reject this statement. Similarly, German scientists expect more strongly than Taiwanese scientists that "journalists should report about research methods and processes so that the general public can understand the reasons for scientific claims" (I8). A likely reason for these differences is the more skeptical view of Taiwanese scientists regarding the ability of the public to understand scientific information. And indeed, when confronted in a separate question with the statement that "the public is not well educated enough to really understand scientific findings", Taiwanese scientists clearly agreed (mean = 0.82, 5-step rating scales as described) while German scientists were ambivalent or even slightly rejected the statement (mean = -0.09). Taiwanese life scientists thus perceive a much stronger need to simplify information about science for the general public than their German colleagues.

In the above-mentioned surveys by Chen (2011) and Peters (1995), in which the opinions of scientists and journalists were compared in a number of aspects, scientists and journalists showed the strongest discrepancy when asked whether journalists should consult the scientists they had interviewed prior to publication of their media stories. The scientists' view on this is replicated in the present survey. Taiwanese and German researchers both strongly agreed with the statement that "journalists should consult the scientists they have interviewed prior to publication in order to avoid making factual errors" (I1). Most likely, the moderate but significant difference in the demand of scientists to be allowed to check journalistic stories prior to publication between Taiwanese and German scientists in our survey is the consequence of the much greater concern about accuracy of coverage on the part of the German researchers as the item used in our survey explicitly mentioned avoidance of factual errors as the goal of consultation prior to publication.

Scientists of both subsamples agree with the item that journalists should "support scientists in educating the general public" (I6). Scientists thus tend to see the media as a means to support their efforts at communicating with the general public, a perception of the role of the media critically discussed by Kohring (2005), for example.

4. Discussion

As expected, the comparison of Taiwanese and German life scientists revealed statistically significant differences in their orientation towards the general mass media. These differences are mostly, but not completely, congruent with our expectation that Taiwanese researchers are less "medialized" than German researchers, i.e. are less prepared to anticipate expectations of journalists towards them and less prepared to accept the typical journalistic way of reporting on science. The responses to the nine items presented in Table 3 indicate that Taiwanese researchers differ from German researchers in the following respects:

1. They show a lower *priority of interactions with the general mass media*, indicated by less readiness to "schedule a lot of time" for media contacts (Table 3, item 9).
2. They are less ready to *adapt to the journalistic style* by using catchy phrases, being entertaining and accepting personalization (Table 3, items 1–3).
3. They are less prepared to *contextualize their research* by relating it to everyday experience and to decisions on the level of society (Table 3, items 4 and 5).
4. They are more inclined to *keep problems and uncertainty confined within science* (Table 3, items 7 and 8).

Taiwanese researchers are thus consistently less inclined to anticipate journalistic expectations when interacting with the media. However, regarding what they expect from journalists, we observed differences to German researchers in their responses to the eight items of Table 4 that at first glance seem somewhat inconsistent:

5. On the one hand, Taiwanese researchers expect from journalists more *consideration of scientific norms and criteria* in media reporting of science than German researchers, such as journalists' orientation to scientific reputation, their anticipation of the priority of scientific publication, and their acknowledgement of the superiority of scientific knowledge (Table 4, items 3, 4 and 7).
6. On the other hand, Taiwanese researchers are less demanding than their German colleagues regarding *accuracy and scientific completeness of media coverage*. Avoidance of factual errors, rejection of compromises with respect to scientific accuracy and inclusion of epistemic information in media stories are more important to German than to Taiwanese researchers (Table 4, items 1, 2 and 8).

While the findings summarized in 1–5 above can be conclusively explained by the hypothesized stronger medialization of German science, the last finding (6) seems to be at odds with this thesis. Peters et al. (2008b) suspect a decreasing weight of "accuracy" as a satisfaction criterion for scientists with increasing medialization. They consider such a trend to be the consequence of scientists' increasing focus on "media visibility" as the principal goal of their strategic communication efforts instead of the earlier, more science-focused criterion of "content quality" in the context of science popularization. Applying that argument to the comparison of Taiwan and Germany, *ceteris paribus* we would expect less concern about content quality in Germany than in Taiwan. In addition to the medialization framework, more concern about accuracy in Taiwan than in Germany would also be predicted by the thesis of a paradigm shift from concern about the scientific literacy of the population towards concern about public trust in science in the Western countries (Bauer, 2008). We thus have to consider factors beyond medialization or a paradigm shift as possible explanations for the lower level of concern about content quality in Taiwan. In the following, we discuss four possible factors that may superimpose on the differences between Taiwanese and German scientists' media orientation resulting from a different degree of "medialization": general cultural differences between Taiwan and Germany regarding, for example, relational concern and post-materialistic values, actual experiences of scientists with the media, perceptions of media impact, and perceptions of the media audience.

(1) Cross-cultural differences in communication priorities: We notice that the items summarized in "consideration of scientific norms and criteria" (5) refer to the social relationship between science and the media and the social status of science, while those summarized in "accuracy and scientific completeness of media coverage" (6) refer to content quality according to scientific criteria. A possible interpretation for the lower level of concern of Taiwanese researchers about content quality in their interactions with journalists would be that in the Confucianist culture of Taiwan the social relations aspects of communication are relatively more important than in Western culture (Chang and Holt, 1994), and the rational concerns regarding content relatively less important. This hypothesis of culturally different communication priorities is consistent with the findings of a study comparing biomedical scientists' motivations regarding interactions with the media across five major knowledge societies – four Western countries (Germany, USA, United Kingdom, France) and Japan. For Japanese biomedical researchers, gaining "public reputation" was a stronger motivator for media interactions than for Western researchers. Conversely, expected impacts on the media audience such as "visibility for sponsors and funding bodies", "more positive public

attitudes", "a better educated public" or "influence on the public debate" were more important motivators for Western than for Japanese researchers (Peters et al., 2008a, Table S8). Furthermore, a clear difference between Taiwan and Germany exists regarding the materialistic or post-materialistic orientation of the population. The World Value Survey of 2006 shows that about 89% of the Taiwanese population tends to be "materialistic" while this proportion in Germany is only 41%.[3] Respectively, the proportion of post-materialists in Taiwan is only very small (11%) while post-materialists are the majority in Germany (59%). We speculate that the dominant conceptualization of science is associated with the materialist vs. post-materialistic orientation of a culture. While in a materialistic culture science may be mainly seen from the utilitarian perspective as a tool for technological and economic progress (a tool managed by technical experts), in post-materialistic societies science may be perceived more strongly as a source of "enlightenment" – a conceptualization requiring in-depth knowledge to be widely shared. The enlightenment concept of science leads to the goal of sharing scientific knowledge with the public; the utilitarian concept of science would be satisfied with the less ambitious goal of communicating technical progress and raising enthusiasm for it.

(2) Experiences with journalistic mass media: Taiwanese researchers have fewer and less positive experiences with journalists than German researchers (Table 2). This may be the consequence of a different type of journalism in the two countries. As already mentioned above, when asked about the type of journalist in the most recent media contact, only 36% of the Taiwanese researchers indicated that the contact was with a science journalist, while this was reported by 61% of the German researchers (Table 2). Correspondingly, the focus of the most recent talk was less frequently on "actual research and findings of this research" in Taiwan (29%) than in Germany (42%) (Table 2). In the majority of media contacts Taiwanese researchers interact with journalists who are not specialized in science reporting, and less often than German researchers they talk about topics directly related to research. Different normative expectations regarding the (scientific) quality of science coverage may thus reflect their actual experiences in different media systems.

(3) Perception of political media impact: More tolerance for low accuracy of media coverage could also be the consequence of perceived political irrelevance of media coverage of science: If the media were without influence, the quality of their content would not matter from a strategic point of view. A different perception of media impact could be caused by a different role of the public in science governance or the development of science-based policies (e.g., on public health) in the two countries. If such issues are dealt with in a technocratic way rather than by public deliberation, media coverage of science and scientific expertise might seem less important. Germany, as other Western countries, is characterized by a decades-long history of science-related public debates and controversies about nuclear power, climate change, environmental risk, biotechnology, use of lab animals and stem cell research, for example, while such controversies rank lower on the public agenda in Taiwan. Furthermore, in the political power structure in Germany the dimension of ecology vs. economy – related to science and technology – is very important (indicated by the rise of the Green Party), while the core dimension in the party system in Taiwan relates to different positions regarding Taiwan's relationship with mainland China. Science-related issues of technology, energy, environment, gene manipulation or bioethics are thus more relevant to the political system in Germany than in Taiwan as many German voters tend to judge the performance of political institutions and organizations with respect to these issues. Media accounts of science and technology may thus be more politically relevant in Germany than in Taiwan. However, the results of our survey do not indicate that Taiwanese and German researchers perceive effects of public communication differently. In both countries, life scientists strongly believe that "greater knowledge on the part of the public leads to more positive attitudes towards science and technology" and "positive public visibility ensures political support for science".[4]

(4) Perceptions of media audience: The worldwide concern about the "scientific literacy" of the population (e.g. Cheng and Shi, 2008; Miller, 1998) shows that science communicators and science communication researchers alike have doubts about the cognitive abilities and prior knowledge of the audience required to understand complex scientific information. This skeptical view may be shared by scientists and may influence their assessment of the adequate complexity level of science news. While information generally should be "accurate", the interpretation of "accuracy" may vary according to the audience. It is quite clear that an audience lacking pre-knowledge and familiarity with the research subject and science in general cannot digest as much scientific detail and sophistication as a scientifically literate audience. If Taiwanese researchers rate the ability of the Taiwanese media audience to understand science information lower than German scientists rate the ability of the German media audience, this could explain their greater concern for simplicity and less concern for accuracy. And indeed, as shown above, Taiwanese researchers are significantly more skeptical regarding the public's ability "to really understand scientific findings" than German researchers. Our results indicate that scientists anticipate the needs and abilities of their audiences in their public communication when considering accuracy. Scientists see a different optimal balance between simplicity and scientific accuracy of information for the general public, determined by their image of the audience.

The discussion of possible explanations for the finding of higher concern about scientific accuracy among German researchers, apparently incongruent with the thesis of different medialization levels in Taiwan and Germany, shows that degree of medialization is not the only difference relevant to public communication of science in the two countries. Nevertheless, there is a clear answer to the research questions raised in the introduction: Taiwanese and German life scientists differ systematically in their responses to items covering various aspects of their media orientation and most differences indicate less anticipation of media criteria by Taiwanese than German researchers. With the exception of desired accuracy of media coverage of science, the empirical findings of our survey are thus consistent with the hypothesis of lower "medialization of science" in Taiwan than in Germany. However, it should be noted that our analysis was confined to indicators showing the adaptation of researchers to the media, not addressing repercussions of that media orientation on science that are hypothesized in the medialization theory as affecting the research process and its outcome.

To explain the inconsistent finding regarding concern about accuracy, four *ad hoc* hypotheses were discussed. Though plausible, there was no empirical evidence supporting the proposed explanation that Taiwanese researchers assign less political impact to mass communication of science and technology than German researchers and thus are less concerned about its content. Most likely, the lower significance of accuracy for Taiwanese researchers is the result of pragmatic adaptation to a media system with less developed science journalism and to an audience perceived as not being very scientifically literate. Although somewhat speculative and requiring further investigation, culturally defined general communication priorities – favoring *relational* over *rational goals* in Taiwan – might also contribute to the different emphasis on accuracy goals in the public communication of science.

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Notes

1. https://www.soscisurvey.de/
2. The response rate was calculated by dividing the number of completed questionnaires by the number of successfully sent invitations. A small number of questionnaires were completed by respondents who

indicated that they did not belong to our target population. These cases were excluded from the list of "valid responses" and were not used in the statistical analysis.

3. The proportion of materialists and post-materialists in both countries was calculated using the online data analysis tool of the World Value Survey's website (http://www.worldvaluessurvey.org, accessed 22 June 2013). The variable analyzed was Inglehart's "Post-Materialist Index 12-item" (Y001) of the fifth wave of the WVS (surveys conducted in 2006). Values 0–2 of the 6-step scale were assumed to indicate a "materialistic" value orientation and values 3–5 a "post-materialistic" orientation.
4. Agreement/disagreement with these items was measured using a 5-step rating scale ranging from -2 ("completely disagree") to +2 ("completely agree"). Mean agreement with the first item was 1.39 (Germany) and 1.36 (Taiwan); mean agreement with the second item was 1.27 (Germany) and 1.21 (Taiwan). Both country differences are not statistically significant.

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